BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

We claim:

1. An article of manufacture suitable for use in determining whether or in what amount a chemical species is present in a target environment, which article comprises a multiplicity of particles in close-packed orientation, said particles having a core of conductive metal or conductive metal alloy, in each said particle such core being of 0.8 to 40.0 nm in maximum dimension, and on said core a ligand shell, of thickness from 0.4 to 4.0 nm, which is capable of interacting with said species such that a property of said multiplicity of particles is altered.

2. An article of manufacture as defined in claim 1, wherein said core comprises silver, gold, platinum or palladium, or an alloy of two or more such metals.

3. An article of manufacture as defined in claim 1, wherein said ligand shell comprises a substance which is capable of interacting with said species such that the conductivity of said multiplicity of particles is altered.

4. An article of manufacture as defined in claim 1, wherein said ligand shell comprises a thiol or an amine.

5. An article of manufacture as defined in claim 4, wherein said ligand shell comprises a thiol selected from the group consisting of primary aliphatic thiols, secondary aliphatic thiols, tertiary aliphatic thiols, heterofunctionally substituted aliphatic thiols, aromatic thiols, heterofunctionally substituted

aromatic thiols, and heterofunctionally substituted araliphatic thiols.

6. An article of manufacture as defined in claim 4, wherein said ligand shell comprises an amine selected from the group consisting of primary aliphatic amines.

7. An article of manufacture as defined in claim 1, wherein in each said particle the core is of size from 2 to 20 nm in maximum dimension and the ligand shell is of thickness from 0.4 to 2.5 nm.

8. An article of manufacture as defined in claim 1, wherein the particles are substantially spherical.

9. A article of manufacture as defined in claim 1, wherein the ligand contains a heterofunctional group capable of binding both with the core and the analyte of interest.

10. A method for investigating a target environment to determine whether or in what amount a chemical species may be present therein, which comprises

(a) exposing to said environment an article of manufacture comprising a multiplicity of particles in close-packed orientation, said particles having a core of conductive metal or conductive metal alloy and deposited thereon a ligand which is capable of interacting with said species such that a property of said multiplicity of particles is altered;

(b) subjecting said multiplicity of particles to conditions sufficient for said property to be exhibited; and

(c) monitoring said property to determine whether there is, or the amount of, any change as an indication of whether, or in what amount, said species is present.

11. A method as defined in claim 10, wherein said core comprises silver, gold, platinum or palladium or an alloy of two or more of such metals.

12. A method as defined in claim 10, wherein said ligand shell comprises a substance which is capable of interacting with said species such that the conductivity of said multiplicity of particles is altered.

13. A method as defined in claim 10, wherein said ligand comprises a thiol or an amine.

14. A method as defined in claim 10, wherein in each said particle the core is of size from 0.8 to 40 nm in maximum dimension and the ligand shell is of thickness from 0.4 to 4.0 nm.

15. A method as defined in claim 10, wherein the particles are substantially spherical.

16. A method as defined in claim 10, wherein the species, when present, can be detected at an amount of 100 ppm or less.

17. A method for investigating a target environment to determine whether, or in what amount, a chemical species may be present, which comprises

(a) exposing to said environment a multiplicity of particles having a core of conductive metal or conductive

metal alloy, in each said particle the core being of from 0.8 to 40.0 nm in maximum dimension, and deposited on said core a ligand shell, of thickness from 0.4 to 4.0 nm, which is capable of interacting with said species such that the electrical conductivity of said multiplicity of particles is altered;

(b) measuring the electrical conductivity of said multiplicity of particles to determine whether there has been, or the amount of, any change in such conductivity compared to the electrical conductivity of such particles not exposed to said environment.

18. A method as defined in claim 17, which comprises exposing the multiplicity of particles to said environment such that when the species is present the ligand shell absorbs said species and swells, with the result that the conductivity of the multiplicity of particles is changed.

19. A method as defined in claim 17, which comprises exposing the multiplicity of particles to said environment such that when the species is present the electronic charge distribution of the ligand shell is altered, with the result of the conductivity of the multiplicity of particles is changed.

20. A method as defined in claim 17, which further comprises comparing (a) the measurement of the conductivity of said multiplicity of particles exposed to said environment and (b) a contemporaneous measurement of the electrical conductivity of a comparable multiplicity of such particles not exposed to said environment.

21. An assembly suitable for investigation of a target environment to determine whether or in what amount a chemical species may be present, which comprises

(a) a substrate suitably configured for presenting a multiplicity of particles supported thereon to contact with said environment;

(b) supported by said substrate, a multiplicity of particles in close-packed orientation, said particles having a core of conductive metal or conductive metal alloy and deposited thereon a ligand which is capable of interacting with said species such that a property of said multiplicity of particles is altered; and

(c) a sensor for monitoring said property of said multiplicity of particles.

22. An assembly as defined in claim 21, wherein said core comprises silver, gold, platinum or palladium or an alloy of two or more of such metals.

23. An assembly as defined in claim 21, wherein said ligand shell comprises a substance which is capable of interacting with said species such that the conductivity of said multiplicity of particles is altered.

24. An assembly as defined in claim 21, wherein the film is of thickness from 5 to 10,000 nm.

25. An assembly suitable for investigating a target environment, to determine whether or in what amount a chemical species may be present, which comprises

(a) a substrate suitably configured for presenting a multiplicity of particles supported thereon to contact with said species;

(b) supported by said substrate, said multiplicity of particles having a core of conductive metal or conductive metal alloy and deposited thereon a ligand which is capable of interacting with said species such that the electrical conductivity of said multiplicity of particles is altered;

(c) a pair of electrodes, each in electrical contact with said multiplicity of particles; and

(d) a sensor for monitoring the electrical conductivity of said multiplicity of particles to determine whether there is, or the amount of, any change in said conductivity as an indication of whether or in what amount said species is present.

26. An assembly as defined in claim 25, wherein the core comprises gold and the ligand is selected from the group consisting of primary aliphatic thiols, secondary aliphatic thiols, tertiary aliphatic thiols, heterofunctionally substituted aliphatic thiols, aromatic thiols, heterofunctionally substituted aromatic thiols, and heterofunctionally substituted araliphatic thiols.

27. A method of fabricating an assembly suitable for investigation of a target environment to determine whether or in what amount a chemical species may be present, which comprises

(a) depositing on a substrate (i) a pair of interdigitated electrodes each having a comb-like configuration and (ii) in such manner that the electrodes are electrically connected, a thin film of a multiplicity of particles having a core of conductive metal or conductive metal alloy, in each said particle the core being from 0.8 to 40.0 nm in maximum dimension, and deposited on said core a ligand shell, of thickness from 0.4 to 4.0 nm, which is capable of interacting with said species such that a property of said multiplicity of particles is altered; and

(b) connecting said pair of electrodes with a sensor capable of determining a change in the property of said multiplicity of particles.

28. A method of fabrication as defined in claim 27, wherein said deposition of a thin film of the multiplicity of particles comprises spraying on the electrodes and on the substrate a solution comprising a salt of each conductive metal to be incorporated in said core, an organic substance having a functional group which is capable of interacting with said species, and a solvent for each said salt and said substance, said electrodes being at a temperature such that the solvent is flashed away.

29. A method of fabrication as defined in claim 27, wherein said deposition of a thin film of the multiplicity of particles comprises

(a) treating said electrodes and substrate with a difunctional material capable of binding with (i) the electrodes

and the substrate and (ii) said multiplicity of said particles, such that said material binds with said electrodes and said substrate;

(b) contacting the treated electrodes and substrate with said multiplicity of particles having a core of conductive metal or conductive metal alloy, in each said particle the core being from 0.8 to 40.0 nm in maximum dimension, and deposited on said core a ligand shell, of thickness from 0.4 to 4.0 nm, which is capable of interacting with said species such that a property of said multiplicity of particles is altered, such that said multiplicity of particles bonds with the material to form a composite comprising a layer of said particles on the electrodes and substrate.

30. A method of fabrication as defined in claim 29, wherein the multiplicity of particles forms a monolayer on said substrate and electrodes.

31. A method of fabrication as defined in claim 27, which further comprises a cycle of steps including

(a) exposing the outwardly facing surfaces of said particles of the composite to a coupling agent capable of bonding said particles to a further multiplicity of such particles deposited thereon, the particles of said further multiplicity having a core of conductive metal or conductive metal alloy, in each said particle the core being from 0.8 to 40.0 nm in maximum dimension, and deposited on said core a ligand shell, of thickness from 0.4 to 4.0 nm, which is capable of interacting

with said species such that a property of said multiplicity of particles is altered; and

(b) contacting the particle surfaces so exposed with said further multiplicity of particles such that said further multiplicity of particles bonds with the particle surfaces of said composite, and the further multiplicity of particles is immobilized on those surfaces.

32. A method of fabrication as defined in claim 31, wherein said cycle is performed a plurality of times.

33. A system suitable for investigating a target environment to determine whether or in what amount a chemical species may be present, which comprises

(a) a multiplicity of particles in close-packed orientation, said particles having a core of conductive metal or conductive metal alloy and deposited thereon a ligand which is capable of interacting with said species such that a property of said multiplicity of particles is altered;

(b) means for exposing said multiplicity of particles to said environment;

(c) means for subjecting said multiplicity of particles to conditions sufficient for said property to be exhibited; and

(d) means for monitoring said property to determine whether there is, or the amount of, any change in such property as an indication of whether or in what amount said species is present.

34. A system for investigating a target environment to determine whether or in what amount a chemical species may be present, which comprises

(a) a multiplicity of particles in close-packed orientation, said particles having a core of conductive metal or conductive metal alloy and deposited thereon a ligand which is capable of interacting with said species such that the electrical resistivity of said multiplicity of particles is altered;

(b) means for exposing said multiplicity of particles to said environment;

(c) means for passing an electrical current through said multiplicity of particles;

(d) means for monitoring the electrical resistivity of said multiplicity of particles to determine whether there is, or the amount of, any change in said resistivity as an indication of whether or in what amount said species is present.

35. A system as defined in claim 34, wherein said means for monitoring the electrical resistivity of said multiplicity of particles includes a current-to-voltage converter circuit followed by a precision rectifier and low-pass filter.

36. A system as defined in claim 35, wherein said means further includes a voltage-to-frequency converter.